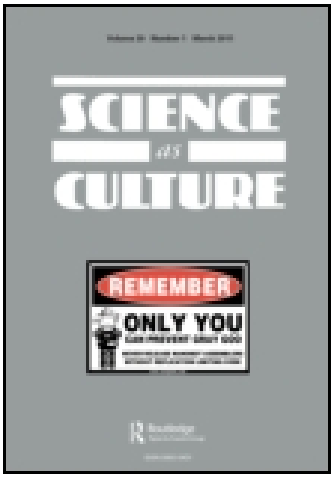

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Science and censorship in an age of bio-weapons threat

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Science and Censorship in an Age of Bio-weapons Threat

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Concerns about the proliferation of biological weapons and the threat posed by their use, whether by warring nations or terrorists, have assumed greater political prominence in recent years. Between the 1960s and 1990s, the issue occupied a relatively low-level place on the international political agenda. However, widespread concern about biological weapons noticeably increased after 9/11 and the anthrax letters which followed shortly afterwards.

In responding to this sense of heightened threat, many governments introduced new legal and defensive measures designed to prevent the misuse of the biological sciences. The USA enacted new measures such as the *Provide Appropriate Tools Required to Intercept and Obstruct Terrorism (Patriot) Act* 2001 and the *Public Health Security and Bioterrorism Preparedness and Response Act* 2002. These placed new restrictions on physical access to, and work performed with, certain pathogens labelled as 'dangerous'. Accompanying such legal measures has also been an increase in investment in civilian bio-defence: the FY2006 budget for example requests a total of $5.1 billion for civilian bio-defence including a request of $1.694 billion for activities sponsored by the National Institutes of Health (Schuler, 2005). As well as governments, other groups in society have also responded to this perceived increase in threat by devising and initiating new forms of governance. These could restrict the dissemination of scientific research containing information labelled as 'security-sensitive'—a term loosely defined as information not easily available from public sources and/or which might be of potential use to terrorists (Bhattacharjee, 2006).

Study of these legal measures and new governance proposals is necessary because, made in the name of national security concerns, they seem to be calling for change to internal governance structures of the scientific community. Proposals to restrict dissemination of science, for example, appear to run counter to the idea that scientific enterprise is built upon an open, full exchange of information, as well as counter to underlying idealistic values of scientific knowledge as common property (see for example Merton, 1973; Richelson, 1998; Shea, 2006). Yet these same proposals are regarded by some in

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the post-9/11 world to be a necessary acknowledgement of 'the reality of a changing world' (Bhattacharjee, 2006); they are framed as prudent, responsible behaviour to ensure that the life sciences are not misused. Herein then lies a central theme in the current policy debate about responses to biothreat: how is science to be conducted, and its results disseminated, in this age of increased biothreat? In order to operationalize this central issue a series of other questions are also considered such as: how is balance to be found between the principles of scientific openness and the efforts to reduce threats posed by biological weapons? Are these two objectives mutually exclusive or can accommodation of both agendas be found? Answers to such questions will evolve over time.

This paper examines how some members of the scientific community proposed an extension of the peer review system to include reviewing manuscripts for information deemed 'security sensitive'. In doing so, this paper will analyse three episodes that are part of an unfolding contemporary event that is likely to continue for the foreseeable future. The first two episodes considered here concern an initial proposal to extend the peer review system to deal with the dissemination of security-sensitive information which was made by a group of journal editors and authors in 2003 and its reinforcement and extension by other sections of the scientific community.

Lying at the heart of these proposals is the currently framed model of threat: that the life sciences can have 'dual uses'. In other words, the same artefacts and information have the simultaneous potential to be applied to both preventing and/or developing biological weapons. A central question to ask then is how does our understanding of this concept affect what is considered to be appropriate responses to the biothreat? As this paper will argue, models of dual use are dependent on specific contexts and actors. In telling the controversy generated during the publication process of a peer review paper about botulinum toxin, this paper will also suggest that 'appropriate policy responses' to the 'dual use' dilemma are also context dependent. Consequently, the controversy around that paper reflects a more general problem about the difficulties of achieving long-term successful collaboration between relevant actors.

The actions and responses examined below are based on public documents available at the time of writing: such documents may not convey the subtleties and nuances in either the relationship or the discussions told here and it is possible that future events might offer new light to aspects of the analysis made here. However, the available documents clearly show an acceptance that certain types of scientific research have 'dual uses' which, despite being performed for legitimate purposes and disseminated via established routes, have the potential to unwittingly assist those who wish to develop biological weapons. Analyses of public statements and documents of these three episodes demonstrate that different frameworks of understanding exist suggesting that understandings of dual use are actor-specific and context dependent.

Conceptualizing Dual Use

The idea that policy responses in one area are modelled on successful policies used in another related area is a standard part of technology governance (Bennett, 1997; Braithwaite and Drahos, 2000), but successful transfer of policy models from one environment to another is dependent upon matching the appropriateness of framing assumptions. Consequently the successful development of policy in the new environment is dependent

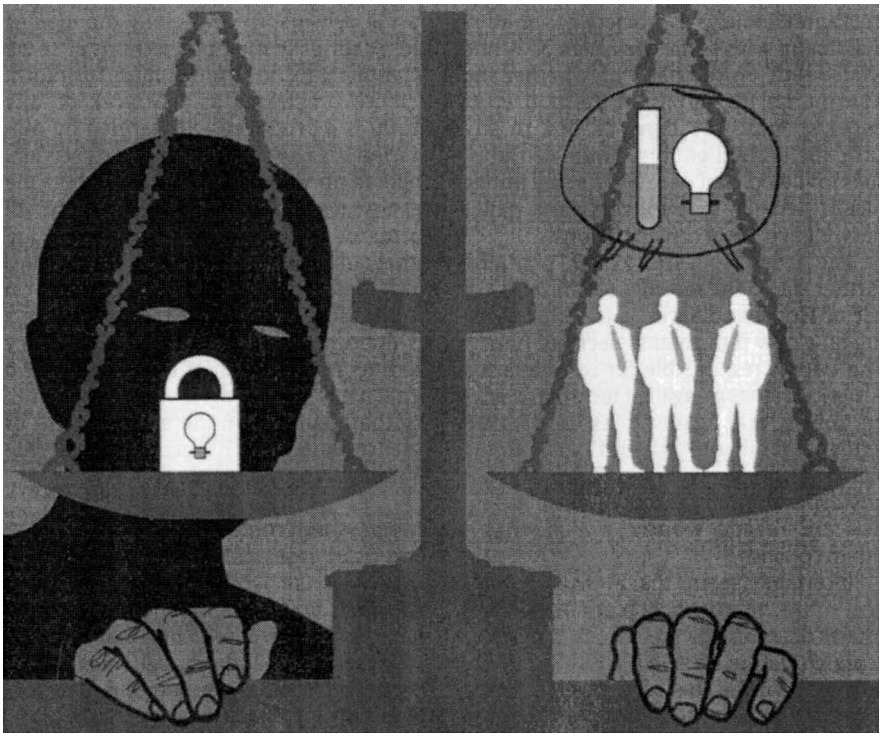

Figure 1. *Credit*: Copyright John McFaul, www.mcfaul.net/weblog,studio@mcfaul.net; reprinted from *The Economist* 9 March 2002

on implicit framing assumptions made by policy makers in the old policy environment. These often unarticulated assumptions form a framework of understanding which guides practical action (Searle, 2001). This mechanism of policy model transfer is evident in current policy discussions by the arms control and disarmament community[1] about how to respond to the threat posed by biological weapons. Underlying assumptions from other arms control policy areas are particularly evident in this field where the framing of the current biothreat is seen to be compounded by the issue of 'dual use' technologies.

As a policy issue the idea that 'dual use' technologies complicates attempts to reduce the threat created by biological weapons is held because, compared to their potential hostile application as a biological weapon, there are a large number of legitimate purposes for which these technologies can be used. These legitimate uses include scientific research, drug and vaccine production, agriculture and industrial processing. Duality makes the design and implementation of effective solutions problematic because policies designed to constrain the acquisition and exploitation of technologies for biological weapons purposes may potentially disrupt these 'legitimate' scientific and technical activities, with corresponding and potentially substantial social costs. Complicating the issue yet further is the notion that the very existence of dual use means that the threat from biological weapons cannot be removed entirely: as long as technologies with relevant dual uses exist and continue to proliferate through these legitimate technology development and research activities, so the threat of misuse remains.[2] As a result, policy responses to the

problem of dual use technologies are balancing acts between: (a) designing adequate countermeasures to reduce the attractiveness of biological weapons, (b) preventing negative applications of the dual use technologies whilst (c) still promoting their spread and use for purposes defined as legitimate by specific actors—e.g. those involved with the scientific establishment, pharmaceutical firms, government, military.

Within the academic literature on technology policy the term 'dual use' is defined as the tangible and intangible features of technologies which enable them to be applied to both (illegitimate) hostile and peaceful ends with few or no modifications (Molas-Gallart and Robinson, 1997).[3] As such, the term is understood to highlight how the same upstream activities, materials, information and equipment can have simultaneous potential hostile and peaceful applications. Within the biological field, the idea that such upstream activities, materials etc. can have dual uses reflects the assumption that what is known about disease and disease-causing mechanisms is intimately linked to considerations about the deliberate spread of disease for hostile purposes (see for example Dando, 1999, 2001; McLeish, 2002). This connection is reinforced by both common and legalistic understandings of what constitutes a biological weapon. For example, according to the legal definition of a biological weapon, accepted by over 155 nations, a biological weapon is defined as:

> Microbial or other biological agents or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes.
> Weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict (BWC, 1972).

This definition also contains directions as to what is to be controlled and labelled as 'legitimate'. Rather than define acceptable technologies or legitimate activities via 'things' the negotiators of the 1972 Biological and Toxin Weapons Convention (BWC), which prohibits the development, production, stockpiling and acquisition of these weapons, chose to define those concepts vis-à-vis purposes. Consequently those activities that use such agents and toxins in types and in quantities that *have justification* for prophylactic, protective or other peaceful purposes are considered legitimate avenues of pursuit—as are the actors who use them in that way.

Because the concept of 'dual use' is central to considerations of policy about biothreat, what is understood by that concept is dependent on how the term 'technology' and its innovation processes are perceived. Several authors, including Winner (1986) and Mitcham (1978, 1994) have argued that far from being neutral, technologies carry encoded politics which mean that conceptions of technology can differ in the way elements are accentuated. Mitcham (1978, 1994) for example, notes that there are differing articulations of the term 'technology' in the philosophies he assigns to two major professional groups: engineers and social scientists. Engineers, Mitcham (1994) argues, generally see 'technology' as 'direct involvement with material construction and the manipulation of artefacts', and regard 'making' as a self-justifying end in itself. Within this framework of understanding, use of the term 'technology' is reserved for the process of material construction and so this framework emphasizes the properties of the technology in question.

By contrast Mitcham notes that social scientists use and extend the definition of technology by also including 'all making of material artifacts, the objects made, their use,

and to some extent their intellectual and social contexts' (Mitcham, 1994; see also Molas-Gallart, 1997a, 1997b, 1998; Autio and Laamanen, 1995). Within this conceptual framework, the artefact/process-alone explanation is not considered as sufficient. Rather, within this framework the specialist knowledge and skills needed to properly recognize and solve technical problems and exploit those solutions efficiently is emphasized (Molas-Gallart, 1997a, 1997b, 1998). Such knowledge is seen as located in people, rather than things, making the ability to recognize technical problems, to solve them, and to use these solutions effectively, a necessary part of the definition of technology. As such, all stages of the technology innovation process, such as the R&D and design phases as well as the socially distributed bodies of knowledge which generate functions, are included in the definition of 'technology' (see Freeman, 1982; Rosenberg, 1982; Autio and Laamanen, 1995; Pavitt, 1999; Nightingale, 2004).

Other authors regard the understandings that Mitcham assigns to these two distinct groups as representative of a normal pattern of evolving conceptualizations of technology. Scholars such as Pavitt (1999), Rosenberg (1982) and Freeman (1982) for example, note that during the Cold War period understandings of technology changed substantially: the early period was marked by a focus on physical artefacts and the process of material construction which then evolved in later years to understanding technology in terms of bodies of knowledge reflecting the *techne* and *-ology* of technology. Today, scholars such as Nightingale (2004) argue that technology should be understood in terms of both physical artefacts (both tangible and intangible) *and* socially distributed bodies of knowledge, both of which only generate functions through their interactions with wider non-technological infrastructures or regimes.

These evolving conceptualizations are similar to changes which have occurred in understandings about the relationship between science and technology. In the initial post World War II period, for example, the focus was on linear models (both science push and market pull), which then evolved into understandings about 'coupling models' that linked research with market demands (i.e. Rothwell, 1977; Kline and Rosenberg, 1986) and then evolved in the post-Cold-War period to focus on 'systems models' which take into account wider institutional and organizational structures that promote the accumulation and diffusion of technological capabilities (see Martin and Nightingale, 2000). Within these more recent 'system models', science is far less likely to take centre stage in the technological innovation process because there is much more appreciation of indirect relationships between science and technology (Rosenberg, 1982), sectoral differences (Pavitt, 1984; Archibugi, 2001) and the role of tacit knowledge, person embodied problem solving skills, instruments and access to networks as the main routes through which scientific research is disseminated (Gibbons and Johnston, 1974; Hicks, 1995).

Both the understanding of technology and the emphasis given to the role of science in the technology innovation process affect the framing of how to understand and appropriately respond to the problems of dual use. For example, within the framework of understanding assigned by Mitcham to the engineers, the 'technology properties' framework, the emphasis in understanding is placed on the ways by which the artefacts used in one area of activity can be adapted and used in other areas of activity. The functions of the technology are considered fixed—not influenced by interactions with other infrastructures—so appropriate policy responses emphasize the invention and diffusion stages of innovation. Threat can be reduced by denying the transfer of technologies and capabilities at these two points of the innovation process, and by denying access to the processes of

material construction and the artefact itself, e.g. through measures such as licensing and export controls.

Within the social scientists' framework of technological understanding, which can be regarded as a 'innovation process' framework, 'dual use' is extended to include the social relations and the modes of production in which development and production of the artefact occur (Galtung, 1979 as cited in Molas-Gallart, 1998). This extended understanding considers both the purpose and context of use, and so regards functions as contingent upon interactions with external infrastructures and regimes (Nightingale, 2004). For those with sympathies to this framework, appropriate policy responses focus on disrupting the entire process of innovation, not simply controlling transfer and access artefacts at the moments of invention and diffusion.

The Current Model of Biothreat

The issue of 'dual use' and how it is understood lies at the heart of recent assessments of the threat posed by biological weapons, as well as more general assessments of the threat posed by weapons of mass destruction. Descriptions of that threat put forward by international organizations such as the United Nations (2006), governments such as US (see for example Department of State, 2006; Director of Central Intelligence, 2003, 2006) and from non-governmental experts (see for example Wilkening, 1999; Sands, 2002) reveal a threat model which contains several conceptual assumptions about dual use. These embedded assumptions can be characterized as: (a) advancing biology is widening the ability of disease to be put to hostile purposes; and (b) increased availability of dual use technologies increases the likelihood that biological weapons will be used. These assumptions reveal an implicit policy response also contained within the threat model, namely to govern the availability of dual use technologies.

History provides some evidence for the first assumption with declassified documents and other sources describing the systematic investigation by several countries (including France, the Soviet Union, the United Kingdom and the United States) into the potential of biological weapons. These documents show that advances made in what have been framed as legitimate purposes, i.e. areas including the life sciences and adjacent disciplines, were also applied to the purpose of biological weapons building. For example, advances in knowledge about how disease takes hold in the human body assisted the development of new delivery techniques, and newly discovered techniques for mass growth and storage of pathogens were put towards increasing efficiency in the development process (see for example Rosebury 1947; SIPRI, 1972).

More recent advances in the life sciences have ensured that the belief that advancing biology could be widening the ability of disease to be put to hostile purposes remains central to biothreat perception. For example, up until recently only two categories of biological warfare (BW) 'agent' could be easily identified: pathogenic micro-organisms able to self-replicate in the host either independently or, in the case of viruses, in conjunction with the host and toxic molecules produced naturally by some micro-organisms and plants and then extracted for use as a weapon. However, authors such as Dando (1999, 2001), Nixdorff *et al.* (2000) and Rappert (2003) regard current advances in the life sciences to mean that these two broad categories may no longer be sufficient. These authors highlight advances in the fields of immunology, virology, genomics, proteomics and the study of pathogenesis and zoonosis as potentially opening up new BW agent categories which

work by reducing the efficiency of the human immune system or by evading natural detection and treatment (see also van Aken and Hammond, 2003; Block, 1999; British Medical Association, 1999). As well as these advances in basic science, the widespread availability of laboratory techniques is also directly relevant to thinking about the relationship between advancing science and the apparent widening of the ability of disease to be put to hostile purposes. Indeed commentators such as Collier *et al.* believe that 'developments over the past 20 years [have] made the production of biological weapons less technically challenging and less capital intensive' (2004, p. 3).

Government statements also promote the assumption that advances in the life sciences and increased availability of laboratory techniques are widening the ability of disease to be put to hostile purposes. For example, in 2001 the US delegation to the BWC noted in its contribution to an assessment of the scientific and technological developments which had taken place since 1996 that major advances had occurred in the fields of 'genetic modification, genomics, proteomics, bioremediation, biocontrol agents, vaccine development and bioinformatics [and that] of special interest to the BWC are applications in directed molecular evolution (i.e., genetic modification), proteomics, bioinformatics, and vaccinology' (BWC, 2001, p. 13). The statement went on to say:

> While offering obvious benefits to mankind, advances in technology can be used to produce new substances or modify old ones and lead to novel and significant toxins and biological or biochemical weapons threats. Nations should remain cognizant of and carefully monitor for potential abuse of these evolving technologies (BWC, 2001, p. 13).1x(4)

Although the US was, and remains, not alone in detailing its apprehension about the potential misuse of advancing biology, its framing of the relationship between advancing biology and the widening ability for disease to be put to hostile purposes is typical. Indeed, the relationship has become so established for most members of the arms control and disarmament community (see note 1) that this assumption is now unquestioningly accepted. For these actors as long as dual use biological technologies continue to develop in their legitimate settings, then the threat from biological weapons will continue to grow.

The framing of the relationship between advancing life sciences and the ability for disease to be put to hostile purposes, and the apparent link to the threat posed by biological weapons leads to the second assumption embedded in the current model of BW threat, that increased availability of dual use biological technology will lead to increases in the possibilities of biological weapons use. This assumption is a deterministic expression of the dual use dilemma which relies upon accepting that dual use technologies have certain inherent properties, for example 'dangerousness'. As mentioned previously, there are a vast number of legitimate purposes which dual use biotechnologies can be put towards, but this assumption frames the diffusion of these technologies through permitted channels for legitimate purposes as 'dangerous' because it simultaneously spreads the capabilities needed to develop biological weapons.

The most significant acceptance of this framing assumption came in the January 1992 summit session of the United National Security Council when proliferation of weapons of mass destruction was declared by the participating heads of state and government as the greatest threat to international peace and security (United Nations Security Council, 1992). Since 1992 the perception that the diffusion of dual use technologies underlying

weapons of mass destruction is the 'new threat' to world peace and stability has been repeatedly uttered (see for example United Nations Secretary-General, 2004; G8, 2003, 2004). This assumption is perceived as having been validated by a series of events, including the discovery that both the Soviet Union and Iraq had developed offensive BW programmes, revelations from the Truth and Reconciliation Committee about a South African BW programme, the 2001 anthrax letter attacks and suggestions in 2001 that Al Qaeda possessed biological weapons.

The 1992 United Nations Security Council statement went on to outline a course of action to counter this threat:

> The members of the Council commit themselves to working *to prevent the spread of technology related to the research for or production of such weapons* and to take appropriate action to that end (emphasis added; United Nations Security Council, 1992).1x(4)

This statement illustrates the implicit course of appropriate action embedded in the current model of biothreat, namely that availability of dual use technologies ought to be governed. Technology governance policies typically take the form of supply side mechanisms such as export controls or licenses that are designed to control the flow of tangible technology in order to prevent or impede acquisition for illegitimate reasons (thereby reducing or maintaining a threat level) (Defense Science Board, 2000). Historical examples can be found in Cold War regimes such as CoCom, The Wassanaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies, which succeeded CoCom in 1994 and most recently in the actions of the Australia Group where participating states believe that controlling access to certain technologies (in this case chemical and biological technologies) will prevent destabilizing accumulations of relevant warfare materials.

The case study presented in the next section is set against this background in which the current policy model embeds a number of specific interdependent assumptions about dual use, BW threat and BW control.

Proposing to Restrict Dissemination

Although recent events such as the terrorist acts on 9/11 and the anthrax letter attacks proved to be a turning point, attempts to find an appropriate balance between the traditional freedom to openly communicate and disseminate scientific results and national security concerns that such unrestricted dissemination might assist a person wanting to employ biological weapons have a much longer history. During the Cold War for example, periodic attempts were made to try to restrict openness and free dissemination on national security grounds in defence-related fields such as aerospace engineering, advanced computer technology, and cryptography. However, belief that openness in science leads to stronger long-term security (National Academy of Sciences, 1982) led President Reagan to issue National Security Decision Directive 189 (NSDD-189), which decreed that there would be 'no restrictions ... upon the conduct or reporting of federally-funded fundamental research that has not received national security classification' (USA, 1985). This directive continued to define and shape US government policy towards open dissemination of scientific research as late as November 2001

when the then National Security Advisor Condoleezza Rice reaffirmed the government's commitment to the policy of NSDD-189.

Despite this reaffirmation, a series of events before 9/11 and the anthrax letters coalesced to promote the sense of a 'new' threat posed by biological weapons which required 'new' and effective countermeasures. Reminiscent of those earlier Cold War days, questions were asked once again of (and by) the scientific community as to what actions they could take to support national efforts to prepare against deliberate attacks using disease and what actions they needed to take to prevent their work from being deliberately misused and contributing to the development of those weapons.

Such questions addressed the increasing unease about the appropriateness of freely disseminating advanced scientific information. Also reminiscent of previous government unease about uncontrolled dissemination in specific scientific fields such as aerospace engineering, advanced computer technology, and cryptography, representatives from the US government introduced the controversial term 'sensitive but unclassified' as a means to restrict dissemination of unclassified information which they believed to have the potential to damage national security.[4] Thus in January 2002 publicly available documents relating to technical aspects of chemical and biological warfare information began to be withdrawn from public access. One month after these 'sensitive but unclassified' documents began to be withdrawn from public access, White House officials were reported by the media to have stated their belief that free dissemination of dual use information was contributing to the increased threat from biological weapons (see Marburger, 2003, p. 3). Indeed prophetically some officials were reported to have proposed that journal editors should not publish 'sections of articles that give experimental details which other scientists would need to replicate the claimed results' (Marburger, 2003, p. 3).

The debate about how appropriate it now was to freely disseminate dual use life science information reached its latest peak with the publication of three papers in peer reviewed scientific journals. The publications—one which inadvertently found that the virulence of mousepox can be enhanced by the incorporation of an immunoregulator gene (Jackson *et al*., 2001); another on the design of variola virus immune evasion (Rosengard *et al*., 2002); and a third on the synthesis of polio virus cDNA without a natural template (Cello *et al*., 2002)—led certain government officials to call for changes to publication procedures (Wallerstein, 2002; Cozzavelli, 2003; Malakoff, 2003). Others inside and outside the scientific community issued comments about the appropriateness and wisdom of continuing to publish cutting edge scientific research in freely accessible journals when the intimate link between life sciences and biological weapons seemed undisputable. An editorial in *New Scientist* for example stated:

> That this mind-boggling quantity of information is going to transform medicine and biology is beyond doubt. But could some of it, in the wrong hands, be a recipe for terror and mayhem? (Editorial, 2002, p. 5).

And bioethicist Arthur Caplan was reported in an *LA Times* article as saying

> We have to get away from the ethos that knowledge is good, knowledge should be publicly available, that information will liberate us. . . . Information will kill us in the techno-terrorist age, and I think it's nuts to put that stuff on Web sites (Lichtblau, 2001 as quoted in Shea, 2006, p. 6).

Of the three publications, the paper by Cello *et al*. (2002) received the most negative attention. The media in particular was very critical of its publication, inferring that synthesis was an easy process and claiming that now any virus could be synthesized from chemical reagents purchased on the open market. This reaction was consistent with media held myths that any 'B-plus high school chemistry student' could produce BW agents, and that biological weapons development is 'as difficult as producing beer' (Leitenberg, 2000). Conflating issues of the legitimacy of disseminating scientific advances with an increased bioterror threat, the media accused the scientific community of disseminating techniques which could make it easier for 'persons or groups' to develop biological weapons.

Reaction from some quarters of the political realm to the same publications also conflated these two distinct issues. In the House of Representatives, for example, Senator Weldon of Florida introduced House Resolution 514 which criticized the Jackson *et al*. paper (2001) by declaring that the *Journal of Virology* had 'publish[ed] a blueprint that could conceivably enable terrorists to inexpensively create human pathogens for release on the people of the United States' (Weldon, 2001). The resolution introduced onto the floor of the House included suggestions that

> (3) The scientific community should develop ethical standards and exercise restraint to ensure that information that may be used by terrorists is not made widely available; and
> (4) The executive branch should examine all policies, including national security directives, relevant to the classification or publication of federally funded research to ensure that, although the free exchange of information is encouraged, information that could be useful in the development of chemical, biological, or nuclear weapons is not made accessible to terrorists or countries of proliferation concern (Weldon, 2001).

Whilst the media voiced their concerns, and politicians introduced resolutions, the National Academy of Sciences reacted by stating that the experiment reported in the most controversial of the three papers, Cello *et al*. (2002), was 'neither a novel discovery nor a potential threat' (National Research Council, 2004, p. 28). The Academy did, however, host a day-long meeting in January 2003 as part of its ongoing explorations about how to achieve an appropriate balance between openness and national security. The day following that particular meeting was a decision by 32 journal editors and authors that a common set of procedures to control the dissemination of certain scientific information needed to be developed. This proposal, effectively issuing preliminary guidelines for an agreed self-governing framework of censorship to be applied during the peer review process, was reprinted in full in *Nature* on 20 February 2003.

When explaining their reasoning behind this proposal, the Journal Editors and Authors Group stated:

> We recognize that the prospect of bioterrorism has raised legitimate concerns about the potential abuse of published information ... We are committed to dealing responsibly and effectively with safety and security issues that may be raised by papers submitted for publication, and to increasing our capacity to identify such issues as they arise ... (Editorial, 2003, p. 771).

And suggested that:

> Scientists and their journals should consider the appropriate level and design of processes to accomplish effective review of papers that raise such security issues. [O]n occasions an editor may conclude that the potential harm of publication outweighs the potential societal benefits ... Under such circumstances, the paper should be modified, or not be published ... (Editorial, 2003, p. 771).

Underpinning and Extending the Journal Editors and Authors Group Proposal

As mentioned, the issue of appropriate dissemination of advanced scientific research is a cross-disciplinary issue within science fields and has a cyclical history. Within this current cycle of interest the Journal Editors and Authors Group was not the first action taken to try and consider what actions ought to be taken to balance scientific openness against national security objectives, given the duality of the knowledge produced in the life sciences. In 2002 for example, the presidents of the US National Academy of Sciences and the UK Royal Society released a joint statement calling on scientists to assist their governments in combating the threat of bioterrorism:

> Today, researchers in the biological sciences again need to take responsibility for helping to prevent the potential misuses of their work, while being careful to preserve the vitality of their disciplines as required to contribute to human welfare (Alberts and May, 2002, p. 1135).

The National Academy had also convened, just a few months prior to this statement, an expert committee to consider ways by which 'an appropriate balance between scientific openness, which is crucial for scientific progress, and the restriction on public information needed to safeguard security' could be achieved (Alberts and May, 2002). The expert committee was charged to:

1. Review the current rules, regulations, and institutional arrangements and processes in the United States that provide oversight of research on pathogens and potentially dangerous biotechnology research, within government laboratories, universities and other research institutions, and industry.
2. Assess the adequacy of current US rules, regulations, and institutional arrangements and processes to prevent the destructive application of biotechnology research.
3. Recommend changes in these practices that could improve US capacity to prevent the destructive application of biotechnology research while still enabling legitimate research to be conducted (National Research Council, 2004, p. 2).

Under the chairmanship of Professor Gerald Fink the committee held six meetings between 1 April 2002 and 29 January 2003. As well as reviewing information available from public literature, there was an opportunity for representatives from the National Institutes of Health, the Executive Office of the President, governmental and non-governmental technical and policy experts, educators and private consultants to brief the Committee about their views on the topic (National Research Council, 2004).

Releasing their report in 2003, the Fink Committee made a series of recommendations including the need to develop a pre-publication review for scientific manuscripts to check for security sensitive information. This reinforced the conceptual basis of the decision made the previous year by the Journal Editors and Authors Group. The panel also agreed with the Journal Editors and Authors Group that the system be self-governing, arguing that scientists and journals should be trusted to screen their papers for security risks rather than have others impose 'mandatory information controls on research in the life sciences' (National Research Council, 2004, p. 101).

However unlike the Journal Editors and Authors Group the Fink Committee's proposal to establish a pre-publication review was considered as only one part of a much larger proposed system of actions which they regarded as necessary and appropriate for the scientific community to take to help ensure that the life sciences were not misused. The Committee for example acknowledged that other opportunities to disseminate research results, which fall short of peer review publication, were available to scientists including presentations at scientific meetings, Internet postings, and email exchanges. As a result underpinning their proposal for a pre-publication review the Fink Committee also recommended a concerted effort to educate all scientists about the nature of the dual use dilemma and their responsibilities to mitigate the risks of misuse. This extended the proposal made by the Journal Editors and Authors Group by acknowledging that all scientists, whether peer reviewers or not, would need to be educated as to what constituted 'dual use'. Similarly, the Fink Committee extended the Journal Editors and Authors Group proposal by recommending a multi-layered oversight arrangement at all stages of the scientific process for experiments conducted in, what the committee regarded as areas of science which 'raise[d] concerns about potential misuse'. The areas identified by the committee as those which should raise concerns about potential misuse are investigations which:

1. demonstrate how to render a vaccine ineffective;
2. confer resistance to therapeutically useful antibiotics or antiviral agents;
3. enhance the virulence of a pathogen or render a non-pathogen virulent;
4. increase transmissibility of a pathogen;
5. alter the host range of a pathogen;
6. enable the evasion of diagnostic detection modalities; or
7. enable the weaponization of a biological agent or toxin (National Research Council, 2004, pp. 5–6).

In the committee's opinion these seven areas of scientific activity would require a process of review and discussion 'by *informed* members of the scientific and medical community *before* [such activities were] undertaken or, if carried out, *before* they are published in full detail' (emphasis added, National Research Council, 2004).

Following the publication of the Fink Report, officials from the Department of Health and Human Services for Public Health Emergency Preparedness (DHHS) announced the establishment of a National Science Advisory Board for Biodefense (NSABB). According to a press release from DHHS (2004), the board was established to provide

> advice to federal departments and agencies on ways to minimize the possibility that knowledge and technologies emanating from vitally important biological research

> will be misused to threaten public health or national security [and to] recommend specific strategies for the efficient and effective oversight of federally conducted or supported potential dual-use biological research taking into consideration both national security concerns and the needs of the research community.

Consisting of 25 voting members who are appointed to the board by the Secretary of DHHS, the board also has a number of non-voting *ex officio* federal members who represent government agencies and departments that conduct or support life sciences research (DHHS, 2004). The NSABB website declares that individuals on the board come from a wide range of scientific fields from molecular biology through public health/epidemiology to scientific publishing as well as non-scientific practitioners and experts from fields such as bioethics, national security, and law enforcement.

The NSABB conducted its inaugural meeting in June 2005 and has met two further times in November 2005 and March 2006. The board is scheduled to have six more meetings before its current mandate expires in February 2008.[5] Like the Fink Committee and the Journal Editors and Authors Group before it, the NSABB clearly expressed their fundamental belief in scientific openness, stating that results ought to be communicated as fully as possible and that communication should only rarely be restricted (see Editorial, 2006).

Testing the System

The guidelines proposed by the Journal Editors and Authors Group, and later by the Fink Committee and reaffirmed by the NSABB, suggest that in certain specific circumstances it might be appropriate to restrict dissemination of scientific results. There are, however, only a very small number of well-documented and publicly acknowledged cases which can be studied to assist in understanding what sorts of circumstances are being referred to. One such case came in May 2005 when journalists reported that a paper submitted to a peer-reviewed journal (which had signed onto the 2003 journal editors' statement) was temporarily withheld from publication as it underwent a special review on the grounds that it contained information with potential national security implications.

The particular paper authored by Lawrence Wein and Yifan Lui (2005) was submitted to *The Proceedings of the National Academy of Sciences (PNAS)* and was approved for publication the week of 20 April 2005 after a standard round of peer review. This paper was distributed as usual to journalists under a publication embargo, and a notification of its impending publication was made in the 'early edition' section of the *PNAS* website. It was later reported that journalists called the Food and Drug Administration (FDA) for comment on the appropriateness of the publication and that it was FDA officials who notified other divisions of the DHHS comment.

Essentially a 'threat assessment', the paper describes how a single terrorist with a few grams of botulinum toxin could deliberately disseminate that toxin into either a holding tank at a dairy farm, a tanker truck transporting milk from a farm to the processing plant, or a raw milk silo at the processing facility. The paper goes on to construct mathematical models to calculate the potential rates of poisoning based on an analysis of the distribution pathways and consumption rates of milk within the US. The authors estimated that in the absence of any detection the mean number of people who would consume the contaminated milk would total 568,000 (Wein and Lui, 2005).

In an editorial written four weeks later president of the National Academy of Sciences, Bruce Alberts, said that by following the recommendations in the Fink report 'possible security issues [had already been] explicitly recognized during the *PNAS* review' but that the reviewers had recommended the paper for publication because in their opinion

> All of the critical information in this article that could be useful to a terrorist—in particular, the LD50 dose of botulinum toxin for humans, toxin heat sensitivity, milk pasteurization conditions, and the size of the milk containers into which milk collections are pooled for pasteurisation—are immediately accessible on the World Wide Web through a simple Google search (Alberts, 2005, p. 9737).

This, however, was not the opinion held by certain government officials. Stewart Simonson, Assistant Secretary of the DHHS, reportedly wrote to Alberts asking that the paper be withdrawn from possible publication because it was 'a road map for terrorists and publication is not in the interests of the United States' (Shane, 2005). According to a *New York Times* journalist, the Simonson letter

> objected to the article's discussion of 'vulnerability nodes' in the milk supply chain, the dose of botulinum toxin required to kill or injure large numbers of people and possible inadequacies in milk testing. The letter said Lester Crawford, the acting commissioner of the Food and Drug Administration, joined in the request not to publish (Shane, 2005).

In light of this direct request from DHHS and FDA officials, the *PNAS* board did temporarily withdraw the paper from publication and the embargo on the paper was extended pending a re-examination of the content in light of comments received.

National Academy of Sciences and *PNAS* representatives reportedly met with government officials, including DHHS officials on 7 June to discuss their specific concerns about the publication of the Wein and Liu article. That meeting took place one week after Lawrence Wein, the principle author of the embargoed paper, had written an Op-Ed article for the *New York Times* summarizing the content of the supposed embargoed paper with some changes—such as on the lone terrorist acquiring the botulinum toxin on the black market, and the terrorist following the instructions found in a web-based Jihadi manual called *Preparation of Botulism Toxin* (Wein, 2005).

Alberts later reported in his editorial that after that meeting '*the Council of the National Academy of Sciences decided* to publish the article *as originally accepted* (after a standard round of final copyediting)' (emphasis added, Alberts, 2005, p. 9738). Although the minutes of the meeting are currently not in the public domain it appears that the government officials did not prove their case that the paper ought to be withdrawn—having said that no indication has been given in the public domain as to what constituted 'a standard round of final copyediting'.

Using the editorial space to make clear the Council's reasons for approving publication Alberts said:

> We are convinced that the guidance offered in this article on how to anticipate, model, and minimize a botulinum toxin attack can be valuable for biodefense. The details of the mathematics used are presented in a lengthy *Supporting Appendix*

> for others to criticize and improve upon. The modelling is useful in demonstrating what changes can and cannot improve our safety. At the same time, three simple facts that are available to anyone interested are sufficient to reproduce the lethality of various doses of the toxin calculated in the Wein and Liu article within a factor of 10—using no mathematics except simple arithmetic. These are the LD50 of the toxin, the size of the pasteurization tanks, and the average amount of milk drunk per person in a household. The authors acknowledge that such unknowns as the true LD50 for humans and the effects of pasteurization on the toxin make their own estimates good only to orders of magnitude. A terrorist who wants to do great damage will therefore not find anything in the article that is likely to increase his or her certainty concerning the minimum level of toxin to use, and we can detect no other information in this article important for a terrorist that is not already immediately available to anyone who has access to information from the World Wide Web (original emphasis, Alberts, 2005).

The Wein and Lui article was published online on 28 June 2005 and in hard copy on 12 July 2005. Dr Wein thanked the Academy for acting 'honorably and professionally' in publishing their article (Meserve, 2005). A spokesperson for Assistant Secretary of the DHHS said that whilst Mr Simonson 'respects the academy's decision' to publish the study, he believed that 'the academy is wrong and that the consequences of publishing could be dire . . .' (Meserve, 2005). The spokesperson then went on to say that Simonson 'still feels strongly that they shouldn't have published. But he can't stop them, so they are going to do it'. In a parting comment, the spokesperson noted that 'it will be HHS and not the academy that will have to deal with the consequences . . .' (Meserve, 2005).

Guiding Actions and Framing Issues

At the time of writing this paper it is not possible to give a full account as to what guided the Journal Editors and Authors Group to take their decision and propose a system whereby under certain circumstances dissemination might be restricted, or what guided the Fink Committee to extend that suggestion. It is, however, possible to propose that the journal editors were not simply acting out of a sense of responsibility. Circumstantial evidence in the form of government comments indicate that they were also coming under pressure to 'be seen to be responding' to the perception of a deterministic link between dissemination of advanced life science work and increasing threat from biological weapons, including bioterrorism. If this did guide their actions, then their proposals can be seen as serving two basic community interests: first, to protect scientific information from potential misuse, and secondly, to be identified as being socially responsible custodians of that knowledge. By making these statements these various representatives of the scientific community can be seen as showing awareness of contemporary issues; sensitivity towards a perception of threat; and willingness to respond to those threats in their efforts to contribute to the protection of the nation.

Following from this service of community interests, is the strong probability that behind these proposals to implement a self-censoring system is another form of self-interest, namely that by being 'seen to be doing something' the possibility of interference in the scientific process from outside parties would be at best avoided, or at worse delayed. Indeed although national security has traditionally been regarded as best served by

allowing the free flow of all scientific and technical information (National Academy of Sciences, 1982), Harris and Steinbruner argue strongly that by the spring of 2002:

> it was clear that the Bush Administration was seriously considering the possibility of restrictions on the dissemination of scientific findings that could have national security implications—what has been called 'sensitive but unclassified' information ... Reports ... emerge[d] about White House plans to develop rules for the dissemination of information that could have national security implications (Harris and Steinbruner, 2005, p. 1).

Indeed the then Associate Director of Homeland Security, Dr Albright, is reported as having clearly stated that 'the science community ought to come up with a process before the public demands the government do it for them ...' (Petro, 2004, p. 66). Seeming to support the possibility that government officials would act if such a system was not considered seriously, Presidential Science Advisor Marburger told a roundtable on Scientific Communication and National Security convened by the National Academies of Science that he was

> *very pleased* with the response of the biopublishing community to the emerging need for attention to what is published in their journals. The joint statement issued by publishers ... is *a big step toward reassuring the public* that the biology community is *willing to take responsibility* for its research in areas that may have a negative impact on biosecurity (emphasis added, Marburger, 2003, p. 2).

With such outside pressures, a strong factor guiding the decision to propose this self-regulating pre-publication review mechanism does seem to be self-interest in the form of self-preservation, i.e. the proposals were motivated by an attempt to forestall the possibility of outside interference. Attempting to define what was sensitive information and how it might best be protected from misuse can be regarded as protecting internal governance structures.

Whether the primary motivation was self-interest, some form of self preservation, or something other, issuing proposals to examine how one might responsibly disseminate dual use information without compromising the scientific process, were timely and prudent given the multiple uncertainties inherent in the threat model and its level of acceptance by society. The proposals can also be seen as prudent at another far deeper level: by taking the lead and being able to quickly reaffirm their commitment to the fundamental principle of openness (as the Journal Editors and Authors Group, the Fink Committee and the NSABB have all done) the burden of proof that unrestricted dissemination does constitute a risk to national security has been placed squarely on the shoulders of those who wish to restrict such dissemination. Given the uncertainties of the threat model and the questionable deterministic nature of this expression of the dual use dilemma, the accumulation of evidence to prove this link is almost impossible to obtain unless a bioterrorist incident occurs. In the absence of that event and without that evidence it is likely that the specific circumstances under which restricted dissemination would be approved are likely to remain highly specific.

When considering under what specific circumstances might restrictions on dissemination be approved it is interesting to consider what features of the Wein and Lui paper

made it a potential candidate, in the eyes of those government officials, for restricted publication and to consider whether the resulting conflict can be regarded as anything other than exception. As previously mentioned, the choice to study the Wein and Lui paper came through it being one of the few well documented cases of a paper undergoing additional pre-publication special review. However, other journal articles have also undergone additional pre-publication review without creating publicly documented conflict. According to evidence presented to the Fink Committee, 313 manuscripts of the 13,929 manuscripts submitted to ASM journals since 2002 have received special screening because of potential security-sensitive material and yet nothing has been reported in the press about conflict or controversy surrounding this process. Similarly, of these 313 manuscripts the Fink Committee was told that two had received additional screening by the full ASM publication board presumably because these two manuscripts contained particularly high levels of dual use information which may be security-sensitive, but again no evidence is available in the public domain of any controversy or conflict which was created during this process (see National Research Council, 2003, 2004). Although proportionally the 313 manuscripts which received special screening represent just over 2% of the total manuscripts received by ASM journals (which are themselves just one set of journals where such dual use research can be published) this figure is not insignificant because it suggests that at least 313 manuscripts have undergone additional screening without any controversy or conflict being caused.

It is also hard to ignore the few other cases in the public domain which are acknowledged as having undergone additional review because of security-sensitive information. What is known of their additional review process seems to lend support to the idea that the Wein and Lui paper was special for reasons other than it requiring an additional pre-publication review .When details do emerge of other cases, again the norm appears to be that little or no controversy is created by additional pre-publication peer review. In March 2003 for example, the journal *Infection and Immunity* reportedly received a paper describing the effects of proteins that accompany botulinum toxin during natural production and assessed the proteins' effects when inhaled. However no controversy was created when it was published. According to reports, editors requested that portions of the paper be modified in order to allay concerns about the dissemination of dual use biological information (see Boyce, 2003; Shea, 2006).

It is not possible to offer a definitive answer as to why the Wein and Lui paper created such great controversy, while other papers did not; there are correctly too few details in the public domain regarding these other special reviews to permit a comprehensive comparitive study. However, it is possible to speculate that both the nature of the Wein and Lui paper and the media interest surrounding its publication meant that the controversy and conflict which did occur ought to be regarded as exceptional. Although Alberts argued, 'all of the critical information in this article ... are immediately accessible on the World Wide Web through a simple Google search' (2005, p. 9737) the Wein and Lui paper is atypical of the papers normally considered as requiring additional review. Rather than being a paper detailing scientific experiments conducted with select agents, this paper details some practicalities of a bioterrorist attack in the course of reporting their mathematical model of numbers of potential casualties such an attack might produce. These practical details include describing successful dissemination techniques using three possible entry points and so as a by-product the authors also describe vulnerabilities in the security of the US diary industry. Such descriptions of vulnerability drew

strong objections by DHHS and FDA officials. Consequently, subsequent interactions between the PNAS editorial board and the DHHS officials about the Wein and Lui paper were considered newsworthy and reported in detail.

Conclusions

Relevant government departments and relevant members of the scientific community have a shared commitment to reduce the possibility that science might be misused for bioterrorist purposes. Apparently little controversy has arisen from additional review of journal articles during the peer review process for 'security sensitive' material. At least 313 manuscripts have undergone additional screening, with few documented disagreements about publication of 'dual use' scientific research. This shared commitment allows for both the attendance and meaningful contribution by government representatives, including those 'from security and military backgrounds', in meetings organized by representatives of the scientific community to examine the issue of responsible dissemination (Editorial, 2006). In general, this commitment has avoided any potential conflict between the two groups.

As an exception, however, controversy arose over the decision to publish the Wein and Lui paper. The resulting conflict between the PNAS editorial board and DHHS representatives suggests that their shared commitment can be undermined by different understandings of the dual use issue. As their position statements indicate, how one understands the dual use issue is context and actor dependent.

For example, in the Alberts editorial, dual use information is presented as useful to prevent or manage the threat from biological weapons; a similar presentation can also be found in the statement by the Journal Editors and Authors Group and in the Fink Report. Downplayed is the potential of that technology to do harm. The model of dual use being advanced in these presentations is one based on the 'social scientists' conceptualization of technology. This considers not only the artefact and process of production, but also the purpose and context of use of the technology, which depends on interactions with wider non-technical infrastructures and regimes.

In this 'innovation process' framework, the potential of technology for both harmful and beneficial applications is recognized, but they are regarded as distinct categories separated by such interactions. Legitimate actors, broadly defined as those who use microbial and other biological agents and toxins in types and in quantities that have justification for prophylactic, protective or other peaceful purposes, will use the information to prevent or manage the threat from biological weapons. The publication of manuscripts in 'sufficient detail to permit reproducibility' is seen as necessary so biomedical research can be advanced and provide the knowledge base for 'building strong biodefence systems' (Editorial, 2003, p. 771).

The public statements and interjections from DHHS officials, however, present a different context in which the 'dual use' dilemma is understood. They emphasize the contribution that dual use technology, including the information contained within peer reviewed articles, makes to the development of biological weapons. This model of dual use is akin to the conceptualization of technology which Mitcham assigns to engineers, whereby the properties of the technological artefact and its method of production are considered linked and fixed to a specific purpose. In this 'technology properties' framework the legitimacy of interactions with wider non-technical infrastructures is not considered to

be strong enough to suppress anxiety about potential illegitimate applications in favour of concentrating on socially beneficial pursuits. Consequently erecting barriers to the transfer and diffusion of dual use technologies, especially at the moments of invention and diffusion, is considered the most appropriate policy response for reducing biothreats. According to this latter framework, as the base of biology advances in legitimate settings, this advancement increases the technology which could also create biological weapons, and so increases the possibility that biological weapons will be used.

Understanding such conceptual frameworks, and illuminating any potential differences between them, is important because the issue of dual use lies at the heart of the current model of biothreat. Indeed the current model of threat can be seen to contain several assumptions based on the potential of technologies to have dual uses. These assumptions can be characterized as: (a) advancing biology is widening the ability of disease to be put to hostile purposes; and (b) increased availability of dual use technologies increases the likelihood that biological weapons will be used. From these assumptions, appropriate policy responses should control availability and access to the dual use technologies.

These understandings of dual use held by relevant actors are central to their threat perceptions. The conflicting responses to publication of the Wein and Lui article do indeed suggest context and actor contingency in framing the dual use problem. Because understandings of dual use are not fixed, they can create conflict and controversy. Efforts to understand such conceptual frameworks should be seen as not only assisting in minimizing potential future conflicts, but also as a means to illuminate different agendas and purposes that may be at stake.

Notes

[1]The term 'arms control and disarmament community' is used as a collective noun to generically describe actors interested in the multiple issues associated with arms control and disarmament. These include, but are not restricted to, members of relevant international organizations, members of relevant government departments such as Foreign Affairs and Defence, non-governmental experts and specialist interest groups such as industry.

[2]To some extent it also forecloses the possibility of doing away with societal vulnerability to them. Vulnerability differs from risk in that it is a system-inherent characteristic, independent of the probability of an event occurring. Reducing vulnerability will always reduce the risk of a negative outcome of an event but not vice versa (see Sarewitz and Pielke Jr, 2002).

[3]The term dual use should not be seen as confined to biological technologies. When the term was first used in the policy literature it was to describe improvements in all innovation and procurement systems of the military sector and was regarded as a positive attribute to a technology. For more on the positive aspects of dual use exploitation see Alic *et al*. (1992) and Molas-Gallart (1997a, 1997b, 2002).

[4]The number of documents thus far withdrawn stands at over 6,600 and government agencies have also removed information from websites or limited public access to them (Broad, 2002). According to Shea (2006) there are several comparable, but dissimilar, definitions of 'sensitive, but unclassified' in use. The Department of State for example describes 'sensitive, but unclassified' as: 'information which warrants a degree of protection and administrative control that meets the criteria for exemption from public disclosure set forth under Sections 552 and 552a of Title 5, United States Code: the Freedom of Information Act and the Privacy Act.61' whereas the Department of Energy's use of the term is described as: 'information for which disclosure, misuse, alteration or destruction could adversely affect national security or government interests'. Shea notes that the Department of Defense maintains several generic types of controlled, unclassified information but does not specify a definition of 'sensitive but unclassified'.

[5]For more information, including the membership and charter of the National Science Advisory Board for Biosecurity, please go to http://www.biosecurityboard.gov/index.asp.

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